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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

Lecture-3 Economic importance of insect pests, diseases and pest risk analysis

ECONOMIC IMPORTANCE OF INSECT PESTS

Usually thought of as a menace various literature, reviewed by the researcher reveal that maximum members of the Class Insecta are useful to the human beings, besides the plants and other animals. In this chapter the researcher tries to elaborate, on a few important ways in which mankind has benefited from the insects.

Insects as Pollinators

Pollination is often considered to be the most useful activity of insects, for human begins. The total value of pollination services rendered by all insects globally has been estimated to be in excess of $100 billion annually. Pollination is required by most of the higher plants, to produce seed for preparation. Of the different pollinating agents, insects are an important one. The term 'entomophilous,' refers to the flowers pollinated by insects.

Insects pollinate almost all kinds of the flowering plants – trees, (fruit and nut), shrubs, vegetables, herbs, crop plants, fibre and oil producing plants, ornamental (garden) plants, leguminous plants, drug plants, etc. Active pollination of plants is mainly carried out by the insects of the Order Hymenoptera (especially, bees). The common insect pollinators include the bees, the flies, butterflies, moths, small beetles, thrips, beside other.

Insects as Predators/ Role in Biological Control

Biological control refers to the use of a living organism to control a species pest. The groups of insects which attack the injurious species (insect pest) are probably of most importance, economically. Biological control through insects, involve the use of the predator species parasite

species and disease, to attack the harmful insects. There are three main ways to achieve the biological control. The three approaches include:

- Classical Biological Control (importation) involves traveling to the country or area from which a newly introduced pest originated and returning with some of the natural enemies that attacked it and kept it from being a pest there.
- Augmentation is a method of increasing the population of a natural enemy which attacks a pest.
- Conservation of natural enemies is an important part in any biology control effort. This involves identifying any factors that limit the effectiveness of a particular natural enemy and changing them to help the beneficial species.
- Another way biological control can be implemented is by raising sterile males in captivity and then releasing them as and when desired.

Insects used in biological control of insect pests might be predators or parasites (parasitoids). Predators are comparatively larger in size and more rapid in action.

The Predator Insect Species include the 1) Ant Lion (larvae), 2) Ambush Bug, 3) Assassin Bug, 4) Bald Faced Hornet, 5) Big Eyed Bugs, 6) Damsel 31 Bug, 7) Damsel Fly/ Dragon Fly, 8) Ground Beetle, 9) Hover Fly / Syrphid Fly (larvae), 10) Hunting Wasps, 11) Lace Wings, 12) Lady Beetle, 13) Minute Pirate Bug, 14) Praying Mantis, 15) Robber Flies, 16) Rove Beetle, 17) Stink Bug, 18) Soldier Beetle, etc.

Parasites are usually much smaller than predators and take longer to become established, but can limit a pest population, much more severely. The Parasite Species of Insects, helping in the biological control of pest insects include, 1) The Wasps, 2) Tachinid Flies, preserved tachinid fly was seen at the Orissa University of Agriculture and Technology (Bhubaneshwar), 3) Fly Parasites, etc.

Insects as Bio-indicators

The broad insect spectrum, reflecting the overall biodiversity, can be used successfully enough, as biological indicators. Moreover, in some regions, there are indicator species.

A **butterfly** acts as a litmus test of our environment, giving as forewarning of pollution or other kinds of habited degradation. Butterflies are generally regarded as ecological indicators. Some insects have proved useful as pollution indicators. Soot or other forms of particulate carbon, constitute important air pollutants.

Peppered Moth (*Biston betularia*) The occurrence of the three morphs (colour forms) - pale (typical), dark and intermediate was thought to be related to the colour of the bark of local birch trees. With increased air pollution, and high soot content, the tree bark became discoloured and dark (sooty) and the numbers of the dark form (carbonaria) increased.

Quite a few insect species are good indications of water pollution. The developmental stages of the May flies (Order Ephemeroptera) are "ecological indicators" of good water quality. The larvae of alderflies and dobson flies (Order Megaloptera) are very intolerant of presence of any kind of pollutant in the stream (their habitat).

Stoneflies are reputed to be very sensitive to a range of industrial pollutants as well as to oxygen deficiency. Their absence or presence, expressed both qualitatively, and quantitatively, can give an indication of the extent of any pollution in that stream.

Dragonflies and damselflies (Odonates) are also bio-indicators. Insects might also be used as biomonitors of metal contamination in environment. Both the distribution and the abundance of aquatic insects are affected even if traces of metal contaminants are present in the water body. "*Lithocerus niloticum* (Hemiptera: Belostomatidae) was reported to be an efficient biomonitors for heavy metal pollution in lakes.

Insects as Producers

Inks and Dyes – Certain insect species can be used to cultivate and/ extract dyes. The most important of these are the cochineal insects. Cochineal is a red dye produced from the body of the insects. "Historically, adult female Mediterranean scales, *Kermes iticies* and *K. vermilio*; Oriental lac insects, *Kerria lacca*; Central European scales, *Porphyrophora polonica*; and New world cochineal scales, *Dactylopius coccus*, were used in the preparation of red dye by a number of indigenous populations."

Oak trees (*Quercus infectoria* Olivier) in Asia and Persia, produce Aleppo galls. "The trees produce gall tissues in response to the chemical substance secreted by the larvae of tiny wasps (*Cynips gallae tinctoriae* Olivier; Hymenoptera: Cynipidae) that infest the trees."

Lac – This is a resinous substance, produced by a scale insect *Laccifer lacca*. Ber, Dhak and Kusum are the most common host trees of the lac insect in India. Besides shellac, lac is the basic ingredient of a vast array of products which include shoe polishes, lithographic ink, glazes in confectionaries, photographic records, hair sprays and hair dyes, buttons, various sealants, electricals (insulators), etc. Beautiful lac jewellery is available in many parts of India. Being natural, biodegrable and non toxic, the lac resin finds use in food, textile and pharmaceutical industries. Most of the lac available on the global scale is produced in India.

Silk and Sericulture – The techniques involved in the efficient rearing of silk worm and in silk production together constitute what is known as 'sericulture.' *Bombyx mori* (L.), is commonly referred to as the 'Silk worm' or the 'Mulberry Silkworm' as it feeds on the leaves of the mulberry tree, or the 'Oriental Silkworm', as in the Orient, sericulture has built up around this insect, and its secretion. *B. mori* occurs in different racial forms.

The silk is a continuous filament fiber consisting of fibroin protein, secreted from two larval salivary glands in the insect's head, and a gum called sericin, which cements the two filaments together. Silkworm larvae secrete this substance to weave cocoons within which they pupate. India is the producer of all five commercially traded varieties of natural silks, including mulberry, tasar, oak, eri, and muga. *B. mori* produces mulberry silk. The remaining four are

produced by *Antheraea mylitta*, *A. proylei*, *Samia cynthia ricini*, *A. mandrina* and *A. assama* respectively. Asia contributes 95% of the total global production of silk, with China leading from the fore front, followed by India.

Honey and Apiculture – Honey is the main byproduct obtained from a bee hive, beside beeswax, pollen, propolis, royal jelly, bee venom and the adult bees alongside the larvae. Mainly being composed of sugars (fructose and glucose), beside water, organic acids, minerals, nitrogenous compounds, in decreasing quantity; honey is considered as the earliest sweetener, known to man. Human beings are said to obtain nutritional benefits (source of energy), beside benefits to – the digestive apparatus, respiratory system, skin, wounds, eye disorders, diabetes, etc. Ayurvedic medicine use honey predominantly as a vehicle for faster absorption of various drugs such as herbal extracts. Honey also finds immense use as a food ingredient.

Beeswax finds use in bee keeping, for the making of wax foundations. Beeswax is easily formed and carved, owing to its plasticity. Its low melting point, allow easy and complete removal from the casting mould. Beside casting and modelling, beeswax is an important ingredient – in products used for make up (cosmetics), in deodorants, in crayons, in food products and processing, industrial technology, in varnishes and polishes. It is the basic ingredient of a candle, common in every household. A traditional method of colouring cloth, batik, is based on the principle that wax protects areas not supposed to be stained by the dye in which the cloth shall be immersed. Used as a coating for medicines and in printing, beeswax is also used for waterproofing of paper and textiles. Honey, beeswax and propolis in different proportions are important ingredients of bathing soaps. Royal jelly obtained from a bee hive has water, protein, sugars, lipids and mineral salts, as its primary constituents. The common uses of royal jelly are as an ingredient – in food products (jelly, juices, etc.), in cosmetics (dermatological preparations). Bee venom is composed of water (88%), glucose, fructose, phospholipids, enzymes, peptides and amines. “Bee venom has long been used in traditional medicine for the treatment of various kinds of rheumatism.” Adult bees and larvae present in a bee hive are used for artificial pollination. Being non – toxic and having considerable protein content, both adult bees and larval forms can be used as a direct source of food (raw, roasted,

fried, boiled and cooked in various ways). The fields of medicine and cosmetology make use of adult bees and larvae, as well.

Insects as Vectors of Disease: Insects are more popular causative agents, when we consider insect involvement in diseases, except on a few occasions when they themselves cause an infection. Insects are thus, vectors (carriers) of pathogens like bacteria, virus, fungi, helminthes (flukes tape worms, round worms): which in turn are the cause of the diseases, occurring in man, animals and plants.

The Order Diptera might be considered most important in this regard, because this contains the mosquitoes and the flies, responsible for transmission of disease, in most cases. Order orders of Insects include Pthiraptera (biting and sucking lice), Siphonaptera (Fleas), Hemiptera (true bugs), beside any others. Order Diptera One of the most important diseases carried by mosquitoes (Culicidae) is Malaria, involving a protozoan, Plasmodium sp. This disease is transmitted by the Anopheles sp. These are about 28 viruses of major public health importance that are transmitted by variety of mosquitoes. Thus, Dengue and Yellow Fever are transmitted by mosquitoes in the genus Aedes. Several kinds of Encephalitis are transmitted by Aedes and Culex mosquito species. Some species of Culex are transmitters of the disease, Filariasis. Actual specimens of mosquitoes although found less in the museums surveyed, enlarged models have been found in many of the alike institutions as well. In some, like the science centres, emphasis was on the need to create awareness about the deadly diseases carried by the mosquitoes. The housefly, (Muscidae) is guilty of transmitting tuberculosis, typhoid, Cholera, yaws, vitis, and several cestode and Nematode worms. Deer flies (Chrysops) carry the filarial worm, *Loa loa* causing loiasis and may be one 39 of the carriers of tularemia, another being horse flies. Both these represent Family Tabanidae and spread trypanosomiaris, as well. Horse flies transmit another one, anthrax. One of the most serious of human diseases is sleeping sickness caused by the *Trypanosoma brucei*, transmitted by the Tsetse Fly (*Glossina* sp.). Cattles are also affected by these flies. Sand flies/ Moth Flies (*Phlebotomus* sp.) in the family Psychodidae carry several Leishmania parasites, one type causes kala azar, also common in Asia. Black flies (Simulidae), spread human onchoceriasis, by carrying a worm, making the affected people go blind. The Eye Fly (*Siphonella funicola*, M.) of the family Chloropidae, found in south India, settles on the human face, especially at the corners of the eyes, causing irritation.

Order Siphonaptera – Normally preferring a single host, the fleas are capable of biting and feeding upon a variety of others, (if deprived of the actual host). Fleas transmit plague (or black death), inflecting human beings, rats and other rodents.

Order Pthiraptera – Modified to move through animal or human hair, these blood sucking insects, not only cause physical (itching) and mental (irritation) discomfort, lice are important vectors of Typhus, Relapsing fever, both of which may be fatal, besides Trench fever.

Order Hemiptera – The bed bug (Cimicidae) feeds on mammalian blood, causing pain and inflammation. Cimex rotundas, S., is a common form occurring in South India, believed to transmit the protozoan causing kala azar, in some parts of India.

Order Lepidoptera – Some moth and butterfly caterpillars possess urticating hairs, causing dermatitis of varying intensity. If the hairs reach a mucous membrane irritation becomes severe, in the human eye this may cause nodular conjunctivitis. If inhaled caterpillar hairs may cause dysproea and if ingested may give rise to crucic stomatits. Moths of the families Pyralidae, Geometridae and Noctuidae include species that feed upon the eye discharges (in various mammals).

Other Orders – Dragonflies (order Odonata), are considered a threat to the poultry industry, in some parts of Europe. Although stingless and not biting, cockroaches (Order Blattodea), are usually associated with filth and unsanitary conditions, thus, might carry a variety of human pathogens on their bodies.

Wasps and bees (Order Hymenoptera) sting, cause swelling, difficulty in breath and severe pain might be associated with the sting. Stag beetle can inflict a painful pinch with its mandibles. *Lytta vesicatoria* (L.) and others like *Mylabris cichorii* (L.) and *Epicatoria hirticornis*, of India, will cause blisters if any of these come in contact or has been rubbed against the skin or has been swallowed. Ambush bugs and giant water bugs are capable of giving a painful bite as are Helgrammites (immature dobsonflies) of the order Megaloptera.

Allergies – The insect allergies are of the contactant and inhalant type. Lepidopteran (moth and butterfly) scales cause respiratory problem. Orthoptera (grasshoppers, crickets, locusts, cockroaches, etc.) induces rhinitis, itching skin, bronchitis and eventually asthma. Coleopteran (beetle and weevil) also induce similar reaction as in case of Orthoptera.

Use of Insects in Medicine: Cantharidine from the blister beetle (Order Coleoptera) has medicinal properties so can be used to treat warts. Haemolymph of cicadas is known to contain antibacterial properties. By products of apiculture, bee pollen, royal jelly and propolis, in addition to honey, have been subjected to trials and experiments, with success, in curing a variety of human ailments, (an example being healing of wounds). There is a long history of the use of some larger fly maggots for the clearing of open wounds. There are reports of its use in both Europe and the USA for special cares." (pp. 48-49). Aborigines of Australia, used the 'Bush Cockroach' as a local anaesthetic. Insects outweigh the rest of the world fauna on land in terms of biomass. Insects form an important part in the web of life.

Entomophagy refers to the use of insects as a source of food. "Insects are an extremely rich source of high quality proteins, fats, essential vitamins, and minerals." Beetles, grasshoppers, caterpillars, termites, weevils, honey bees and their larvae, beside many more are consumed in the different parts of the globe in one form or the other, because of their high nutritional value. Although, not a popular or regular food option/ choice, insects have been consumed, in certain parts of India too. Eating insects is not a popular practice in India. One reason may be the absence of any information or display of any kind pertaining to 'entomophagy' in any of the museums surveyed across India. Since quite early, insects were the religious symbols in different cultures. Scarab beetle (Family: Scarabaeidae), formed the central religious artefacts amongst the Egyptians. Cicadas were the symbol of birth or immortality, for the Chinese. The praying mantis was the symbol of creation and patience amongst the San of the Kalahari. Beetles have for long found use in jewellery and textile. "In Mughal times, a Jaipur noble's prized patka or such, flashes in the sunlight, resplendent with glided metallic work, and accents of iridescent blue-green- 42 violet gleam like the rarest enameled jewelry.

Other insects also find place human culture. "Butterflies and moths remain prominent in fine art, advertising fashion and Jewelry. Dragonflies have been popular subjects for poetry and paintings. The insect world has its own singers, Orthoptera, being the best known Order of singing insects (crickets, grasshoppers, katydids). Other orders with singing insects include – Coleoptera, Hymenoptera, Isoptera, Homoptera and Lepidoptera. The sound produced by the insects, obviously is a means of communication, in the performance of a specific function. The

sounds created might bear resemblance with some the musical instruments used by the human beings.

Forensic entomology refers to the use of insects in forensic investigation. Depending on the biogeographical region and ecological habitat, different species of necrophagous insects are involved in the decay of a corpse. The insect species with specialised habitat requirements will help yield information on the locality. The primary purpose of forensic entomology, in the present day context, is the use of insects in determining the elapsed time since death, the insect species which can give seasonal information, helps to pinpoint the time of death. Flies (blow flies, carrion flies, house flies, flesh flies, etc.); beetles (histers, dermestids, etc.); some ant species and other insects, find use in the arena of forensic science, their role in this field seems irreplaceable by any other organism.

Insects as decomposers and recyclers are also very important for our environment and human beings, as well. Dung beetle, other beetle groups, flies, blowflies, flesh flies, crane flies, termites, cockroaches, etc., behave as scavengers, feeding upon or rather cleaning up, dung, dead animals and dead plant material. In a way these acts as decomposers, breaking down the complex matter and adding nutrients to the soil, thus, enable nutrient recycling. The digging act and the tunneling performed by these organisms, result in the aeration of soil, besides, transferring nutrients to the soil. Spingtails and bristle tails also act as decomposers of organic matter and help in nutrient recycling. All these insects are responsible for much of the process by which the top soil of the earth's crust is created.